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GB 2218057 A GB 1587855 A US 5830294 A
US 5535798 A US 4481992 A JP 080011508 A

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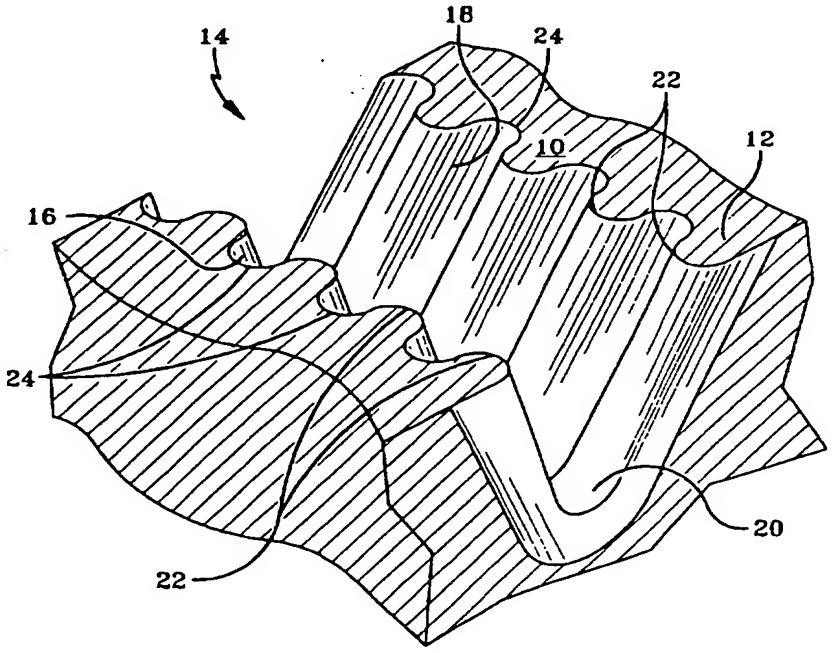
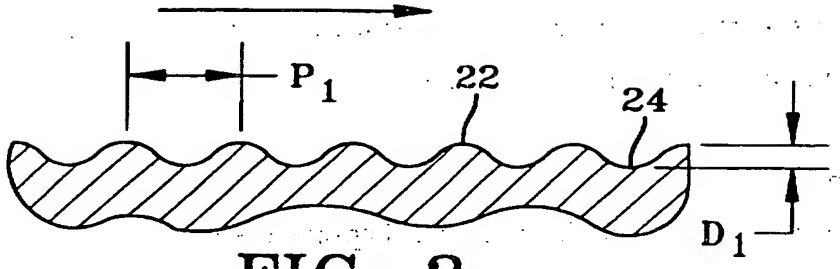
(54) Abstract Title
Pneumatic tyre tread

(57) An external surface 12 of the tread has at least one groove 14 for enclosing and channeling water during use on wet pavement and having at least two surfaces defining the groove, including two side surfaces 16, 18. A series of peaks 22 and valleys 24 extend across each side surface 16, 18, at least half of the valleys 24 having a direction angled 45°-90° to a median plane of the groove. The average distance between each peak 22 and its adjacent valley 24 is from 5°-15° of the average width of the groove. The peaks 22 and valleys 24 on a first side surface 16 can be 180 degrees out of phase from the peaks 22 and valleys 24 on the second side surface 18. The pitch of the peaks and grooves can vary.

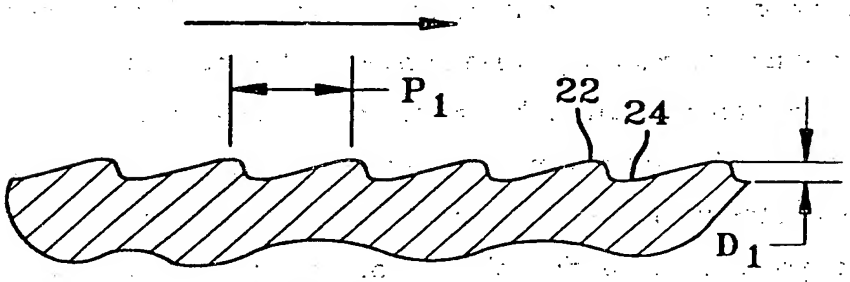


FIG–7

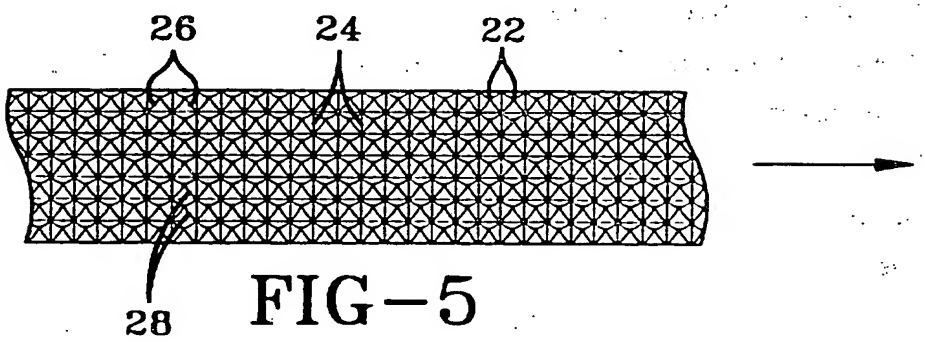
GB 2 363 100 A



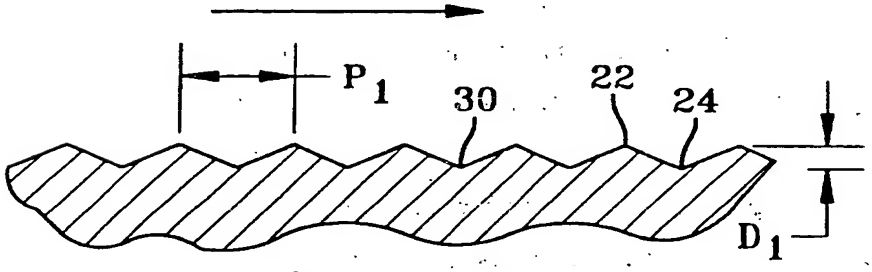
FIG–3



FIG–4



FIG–5



FIG–6

PNEUMATIC TIRE TREAD

Technical Field

This invention relates to the tread of a pneumatic tire and, more particularly, to the ability of a groove within the tread to eject water.

Background Art

Tire designers are continually striving to improve tire performance. One goal in improving tire performance is to improve the traction between the tire and the road surface in wet conditions. When a vehicle is travelling on a wet road surface at high speeds, hydroplaning of the tires can occur. Hydroplaning is caused by the tire pushing water in front of it as it advances along a road surface. As the tire continues to push the water in front of it, the back pressure of the water increases and progressively lifts the tire ground-contact area off of the pavement. This back pressure is a function of the depth of the water and the speed of the tire. Eventually, with sufficiently deep water and tire speed, the back pressure lifts the tire off of the road surface. When a tire is hydroplaning, there is no traction between the tire and the road surface and thus, control of that tire is lost.

To prevent hydroplaning, tire designers are continually attempting to improve the ability of a tire to eject or channel water away from the tire. U.S. Pat 5,503,206 discloses a tire having improved wet traction to avoid hydroplaning. The tire that is disclosed in this patent has an annular aqua channel and lateral grooves that direct water from the footprint to either the shoulder area or the aqua channel of the tire where it is ejected away from the tire.

Providing grooves for the water to flow through is the first step in improving a tire's wet traction. The second step in ensuring that the tire can efficiently eject the water from these grooves. As the tire travels along the road surface, each groove within the tire ground-contact area forms a channel that is enclosed on all sides.

Since each groove within the tire ground-contact area forms a channel, to roughly estimate whether the water flow through each groove is laminar or turbulent, the groove section located in the tire ground-contact area can be analogized to a pipe. The determination of whether flow through a pipe is laminar or turbulent flow is determined by calculating the Reynolds number Re. The Reynolds number Re for flow though a

pipelines, as suggested by U.S. Patent 4,907,765. However, drag reduction devices have never been incorporated into tire technology. Although the flow of water through a tread groove may be analogous to the flow of water through a pipe, a tire designer would not look to pipe technology in designing a tread. First, the leading edge of the tire footprint attempts push much of the surface water out of the path of the tire. Secondly, for the water that does enter the grooves, there are three main distinctions between the flow of water through a tread groove and that through a pipe: (1) in a pipe, the water is in motion whereas, in a tread groove, the water is relatively stationary and the groove is in motion; (2) the water flowing through a pipe is in motion relative to all sides of the pipe; whereas, in a tread groove, the water flowing through the groove is in motion relative to only a portion of the enclosed channel since there is little or no motion of the water relative to the ground surface, and (3) in a pipe, the pipe walls remain stationary; whereas, in a tire tread, the surfaces of a groove are subject to vibrations when the tire is in motion. Even when the pressure of the water entering the groove near the leading edge of the tire footprint creates motion of the water forcing it toward the rear of the footprint, the velocity of the water across the road surface if minimal compared to that across the surface of the groove.

International Patent Application Number PCT/JP94/02229 to Fukato disclosed a groove in a tread surface of a tire having a continuously waved bottom surface whose top does not reach the tread surface which claims to increase the ability to discharge water while avoiding an increase in the proportion of the groove. Unfortunately, because such a groove requires a bottom surface, that groove inherently must be very wide to have any effect. The paradox is wide grooves already have the capacity to discharge large volumes of water and resist hydroplaning. Applicants present invention works efficiently on narrow "V" shaped grooves having no bottom surface or narrow bottom surfaces. Greatly increasing the value of the invention concept allowing for greatly reduced groove void volumes that are superior in water discharging than conventional grooves.

Summary of the Invention

This invention provides a tire tread for a pneumatic tire. An external surface of the tread has at least one groove for enclosing and channeling water during use of the tire on wet pavement. The groove has at least two surfaces defining a channel. The two surfaces include two side surfaces. The respective side surfaces begin at the external surface of the tread and extend radially inwardly toward an axis of rotation of the tire.

"narrow" groove has a width in the range from about 0.8% to 3% of the compensated tread width and a "wide" groove has a width greater than 3% thereof.

"Laminar flow" means streamline flow of an incompressible, viscous Newtonian fluid; all particles of the fluid move in distinct and separate lines.

"Pneumatic tire" means a laminated mechanical device of generally toroidal shape, usually open torus, having beads and a tread and made of rubber, chemicals, fabric and steel or other materials. When mounted on the wheel of a motor vehicle, the tire through its tread provides traction and contains the fluid that sustains the vehicle load.

"Reynolds number" is a dimensionless number that is significant in the design of a model of any system in which the effect of viscosity is important in controlling the velocities or the flow pattern of the fluid.

"Tread" means a molded rubber component which, when bonded to a tire casing, includes that portion of the tire that comes into contact with the road when the tire is normally inflated and under normal load.

"Turbulent flow" means flow in which the motion of the fluid is subjected to irregular velocities and pressures and results in motion in a random manner. Eddies are located in turbulent flow.

Brief Description of Drawings

The invention will be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is depicts the flow of water through a prior art groove on a tire tread;

FIG. 2 is depicts the flow of water through a groove of the invention;

FIG. 3 is a view of an embodiment of the groove surface undulations;

FIG. 4 is a view of a second embodiment of the groove surface undulations;

FIG. 5 is a view of a third embodiment of the groove surface undulations;

FIG. 6 is a view of a fourth embodiment of the groove surface undulations;

FIG. 7 is a view of a preferred embodiment of the groove surface undulations.

Detailed Description of the Invention

Fig. 2 depicts the flow of water through the groove 14 of a tire tread 10. The groove 14 contains a series of peaks 22 and valleys 24, also called eddy breakup devices. The surfaces of the groove 14 in the tire tread 10 include at least two surfaces. The groove illustrated in Fig. 2 contains three surfaces, a first side surface 16, a second side

D1 of each peak 22 varies as it extends across the respective surface. This varied depth D1 can be used to form a number of riblets 26. The riblets 26 may be separated by valleys 24 formed by V-shaped grooves 28 or smooth grooves. The peak 22 of each riblet 26 may come to a point or may be smooth. As with the previous peaks 22 and valleys 24, the pitch P1 and the depth D1 of the riblets 26 can be optimized for a particular Reynolds number. For best results the entire surface of the groove 14 should be covered with riblets 26, as illustrated. Fig. 6 shows a view of an embodiment of the peaks 22 and valleys 24 being separated by a series of V-shaped grooves 28 where the depth D1 of each peak 22 does not vary as it extends across a groove surface.

Fig. 7 is a view of a preferred embodiment of a groove 14 having peaks 22 and valleys 24. These surface peaks 22 and valleys 24 are sinusoidal waves. The peaks 22 and valleys 24 are present on two opposing surfaces and extend from the external surface 12 of the tread 10 adjacent a first side surface 16 to an external surface 12 of the tread 12 adjacent a second side surface 18. The groove 14 is shaped such that the surface peaks 22 and valleys 24 on the first side surface 16 are interconnected to those on the bottom 20 which are interconnected to those on the second side surface 18. Thus, the surface peaks 22 and valleys 24 on the first side surface 16 have the same wavelength as the surface peaks 22 and valleys 24 on the second side surface 18 and the bottom 20. The surface peaks 22 and valleys 24 of the first side surface 16 are 180 degrees out of phase from the surface peaks 22 and valleys 24 of the second side surface 18. In this preferred embodiment, the surface peaks 22 and valleys 24 are symmetrical such that the tire containing these surface peaks 22 and valleys 24 can be non-directional. The peaks 22 and valleys 24 that are not symmetrical, such as those depicted in Fig. 4, must be located on a directional tire to work at their optimal level.

The groove 14, in the preferred embodiment, has a depth defined by an average distance from the external surface 12 of the tread 10 to the bottom surface 20. A median plane bisects the channel formed by the respective surfaces of the groove 14. An imaginary line or arc is located on the median plane within the depth of the groove 14. If the groove 14 runs circumferentially, then the imaginary arc will follow the curvature of the tire. At least half of the valleys 24 of the respective surface containing the peaks 22 and valleys 24 following imaginary lines that are skewed with respect to the median plane line or arc by an angle in the range of from 45 degrees to 90 degrees. In the preferred embodiment, the valleys following imaginary lines that are skewed with respect to the median plane line or arc by an angle of 90 degrees. This angle measured

CLAIMS:

1. A tread for a pneumatic tire, an external surface of the tread having at least one groove for enclosing and channeling water during use of the tire on wet pavement, the groove having at least two surfaces defining a channel, the surfaces including two side surfaces, the respective side surfaces beginning at the external surface of the tread and extending radially inwardly toward an axis of rotation of the tire, the two side surfaces either intersecting with one another or with a bottom surface, the groove having a depth defined by an average distance from the external surface of the bead to the intersection of the two side surfaces or to the bottom surface, a median plane bisecting the channel formed by the respective surfaces of the groove, the groove having a width defined by twice an average distance from the median plane to a respective side surface, the tread being characterized by:

a series of peaks and valleys located on both side surfaces of the groove, an imaginary line or arc located on the median plane within the depth of the groove, at least half of the valleys following imaginary lines that are skewed with respect to the median plane line or arc by an angle or angles in the range of from 45 degrees to 90 degrees, each peak having a maximum depth of 15% of the groove width and a minimum depth of at least 5% of the groove width, the depth being defined as the average distance from the peak to the valley.

2. A tire tread as claimed in claim 1, the tread being further characterized by a pitch between respective peaks varying along a length of the groove.

3. A tire tread as clamed in claim 1 or claim 2, the tread being further characterized by the series of peaks and valleys being on both side surfaces, the peaks and valleys of the two side surfaces having identical wavelengths and the peaks and valleys on a first surface being 180 degrees out of phase from the peaks and valleys of a second surface.

4. A tire tread as claimed in any one of claims 1 to 3, the tread being further characterized by the depth (D1) of each peak varying as it extends transversely across a respective surface.

The Patent Office
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Application No: GB 0113241.4 **Examiner:** Roger Binding
Claims searched: 1-5 **Date of search:** 3 September 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): B7C (CDJ)

Int Cl (Ed.7): B60C 11/04, 11/06, 11/08, 11/13

Other: Online WPI EPODOC JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2218057 A	(DUNLOP), see especially Fig 2.	1, 4
X	GB 1587855 A	(BRIDGESTONE), see especially Fig 7 and page 4, lines 11 to 15.	1
X	US 5830294 A	(SHIBATA), see especially Fig 11 and column 7, lines 16 to 30.	1, 3
X	US 5535798 A	(NAKAMURA)	1, 4
X	US 4481992 A	(TAKIGAWA), see especially column 2, line 64, to column 3, line 2.	1, 2
X	JP 080011508 A (BRIDGESTONE) 16.01.96 (see the Figs, column 4, lines 2 and 3, and abstracts).		1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.